Astronomy Budget Outlook

Mitch Ambrose, Director of Science Policy News and Analysis
American Institute of Physics

9/19/2024

Outline

- Intro to AIP's science policy news service, called FYI
- Macro budget outlook
- Key members of Congress for science funding
- FY25 science budget proposals

FYI: Science Policy News

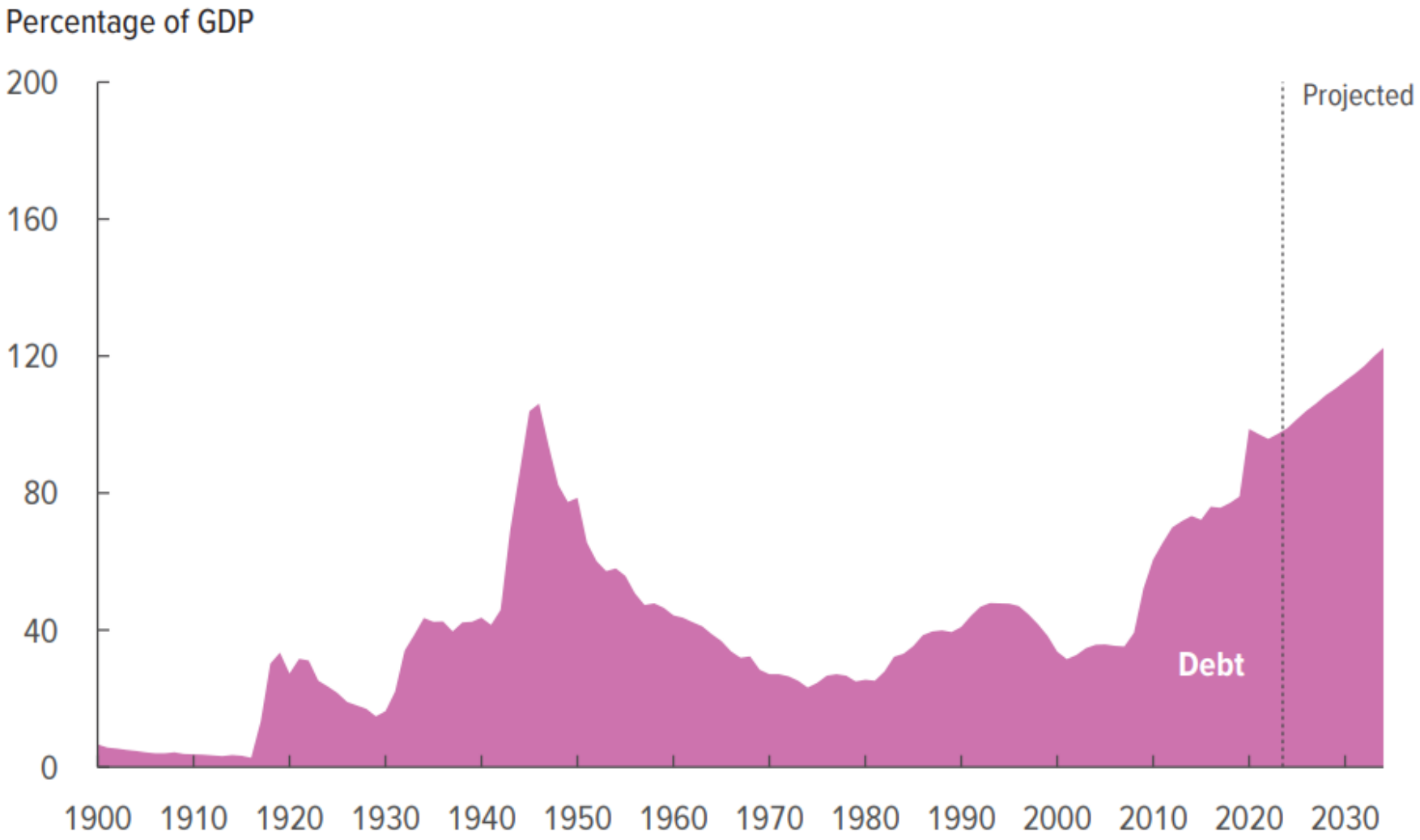
https://ww2.aip.org/fyi

Macro budget outlook

- Recent special appropriations measures included huge amounts of money for R&D, though mostly for applied research and technology development:
  - Pandemic response and recovery legislation (mainly HHS/CDC/NIH)
  - Infrastructure Investment and Jobs Act (mainly DOE and NOAA)
  - Inflation Reduction Act (again mainly DOE and NOAA)
    - $1.5 billion for DOE Office of Science infrastructure
  - CHIPS and Science Act ($54 billion for semiconductor initiatives)
- These measures have contributed to renewed concerns about federal deficits and debt

Federal Debt Held by the Public

Debt held by the public rises in each year, from 99 percent of GDP in 2024 to 122 percent in 2034—higher than at any point in history.



https://www.cbo.gov/system/files/2024-06/60039-Outlook-2024.pdf

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Macro budget outlook (1)

- Budget caps for FY24 and FY25 hold non-defense spending roughly flat
- House has advanced partisan spending bills that undershoot the FY25 caps
- Senate has advanced bipartisan spending bills that exceed the caps
- Likely to be a stopgap measure that runs past the election, might go into the new administration

Macro budget outlook (2)

- A primary motivator for increasing R&D budgets is US-China competition
- Main interest is in strategic technology areas (semiconductors, AI, biotechnology, etc.)
- Yet Congress seems unlikely to meet the science budgets targets set in the CHIPS in Science Act
- However, Senate Majority Leader Chuck Schumer (D-NY) has expressed interest in crafting a follow-on to the CHIPS and Science Act that would focus on other technology areas

Senate AI Blueprint Proposes ‘Emergency’ R&D Surge

MAY 15, 2024

A new bipartisan blueprint endorsed by the Senate majority leader proposes using “emergency” appropriations to ramp up non-defense AI R&D spending to at least $32 billion per year, with some of the money going to broader priorities such as implementing the CHIPS and Science Act.

Mitch Ambrose

Senate Majority Leader Chuck Schumer (D-NY) speaks at a May 15 press conference on artificial intelligence policy. (Bill Clark / CQ Roll Call)

Blueprint proposes Congress increase funding for non-defense AI R&D across the government to at least $32 billion per year, matching the level proposed in 2021 by the National Security Commission on AI.

The commission estimated that federal agencies spent about $1 billion on such R&D in fiscal year 2020 and proposed that Congress double that figure each year over five years.

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Accordingly, the group calls for Congress to use emergency appropriations to “fill the gap between current spending levels and the NSCAI-recommended level.” It also identifies priority programs for the funds to be spent on, such as:

- A cross-government AI R&D effort that spans the Department of Energy, National Science Foundation, National Institute of Standards and Technology, National Institutes of Health, NASA, and other relevant agencies;
- An “AI-ready data” initiative that has a focus on “fundamental and applied science, such as biotechnology, advanced computing, robotics, and materials science";
- Efforts authorized by the CHIPS and Science Act that have not been fully funded, including but not limited to NSF’s education programs and its Directorate for Technology, Innovation, and Partnerships, DOE’s advanced computing and microelectronics programs, and the Commerce Department’s regional technology development hubs;
- NSF’s National AI Research Resource and its National AI Research Institutes;
- “AI Grand Challenge” programs that focus in part on developing applications to “fundamentally transform the process of science, engineering, or medicine";
- NIST’s AI programs as well as construction projects to “address years of backlog in maintaining NIST’s physical infrastructure"; and
- A joint NIST-DOE test bed to “identify, test, and synthesize new materials to support advanced manufacturing through the use of AI, autonomous laboratories, and AI integration with other emerging technologies, such as quantum computing and robotics.”

https://ww2.aip.org/fyi/senate-ai-blueprint-proposes-emergency-r-d-surge

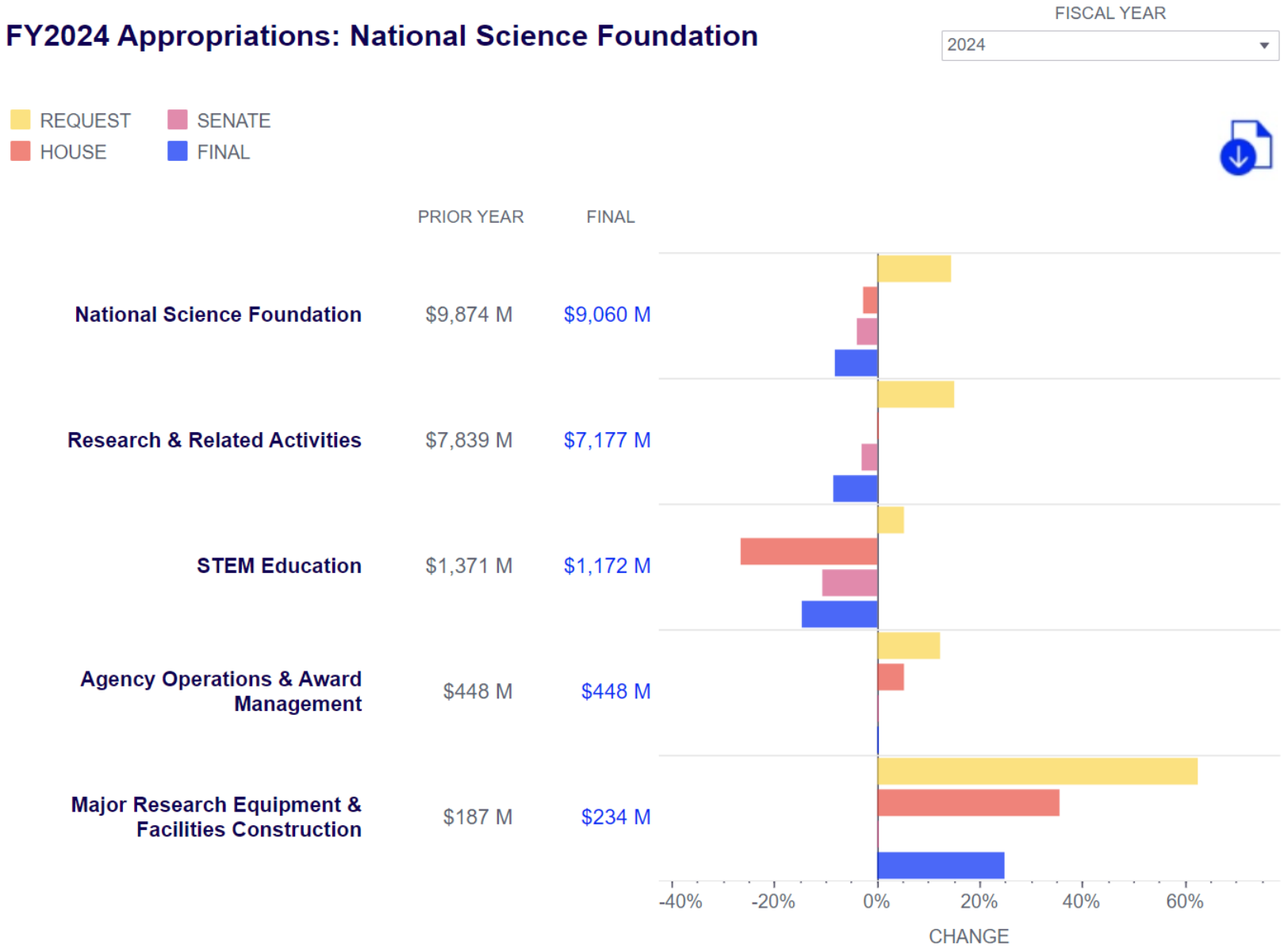
FY24 budget outlook (what I told you last year)

- DOE Office of Science budget proposals relatively favorable given the tight budget outlook
  - House proposing flat funding, Senate a 4% increase
- NSF topline slated for cuts
  - House proposing 2% cut, Senate a 4% cut
- NASA Science Mission Directorate has the worst outlook among these three agencies
  - House proposing 5% cut, Senate a 6% cut
  - Mars Sample Return cost overrun diverting funds from other missions

FY24 budget outcome

- DOE Office of Science budget increased by 1.7%
- NSF budget cut by about 5% or 8%, depending on how you define the baseline
- NASA Science Mission Directorate budget cut by 5.9%
  - Cut fell entirely on the Planetary Science Division
  - Astrophysics Division increased by 1.3%

FY2024 Appropriations: National Science Foundation



https://ww2.aip.org/fyi/fy2024-national-science-foundation

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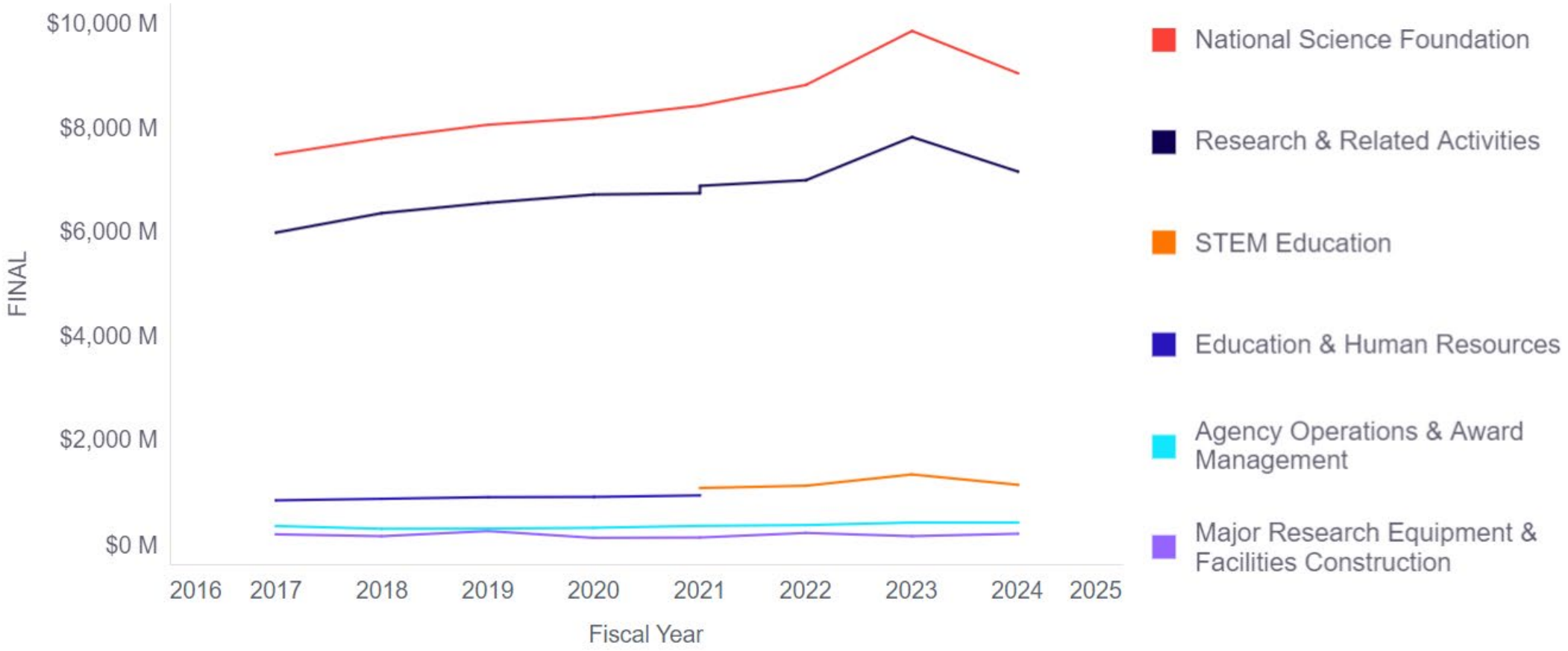
Appropriations History



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	FY23 Plan	FY24 Plan	% Change
Research and Related Activities Total	7,631	7,177	-6.0%
Geosciences	1,592	1,577	-0.9%
Polar Programs	539	560	3.9%
All Other Programs	1,053	1,017	-3.4%
Mathematical and Physical Sciences	1,660	1,554	-6.4%
Computer and Information S&E	1,036	989	-4.5%
Biological Sciences	845	790	-6.5%
Engineering	798	741	-7.1%
Technology, Innovation, and Partnerships	664	618	-7.0%
Integrative Activities	531	552	3.8%
Social, Behavioral, and Economic Sciences	309	290	-6.1%
International Science and Engineering	68	64	-6.9%

FY23 numbers from FY25 budget request

FY24 numbers from https://new.nsf.gov/about/budget/fy2024/appropriations

What NSF wanted to happen (1)

NSF Research Budget by Directorate ($ in millions)	FY21	FY22 Actual		FY23 Estimate		FY24 Request	
NSF Total	8,440	8,676	3%	9,874	14%	11,315	15%
Technology, Innovation, & Partnerships	369	413	12%	880	113%	1,186	35%
Math & Physical Sciences	1,593	1,615	1%	1,686	4%	1,836	9%
Geosciences (incl. Polar Programs)	1,488	1,580	6%	1,613	2%	1,802	12%
Computer & Information Sciences & Engineering	1,007	1,015	1%	1,051	4%	1,172	12%
Engineering	764	775	1%	809	4%	970	20%
Biological Sciences	817	832	2%	857	3%	972	13%
Social, Behaviorial, & Economic Sciences	282	286	1%	313	10%	361	15%

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FYI Science Policy | aip.org/fyi

https://ww2.aip.org/fyi/2023/nsf-details-plans-spend-1-billion-budget-increase

What NSF wanted to happen (2)

NSF Math and Physical Sciences Directorate Budget ($ in millions)	FY21	FY22 Actual		FY23 Estimate		FY24 Request	
NSF Total	8,440	8,676	3%	9,874	14%	11,315	15%
Math & Physical Sciences Directorate	1,593	1,615	1%	1,686	4%	1,836	9%
Astronomy Division	289	284	-2%	292	3%	303	4%
Chemistry Division	260	265	2%	269	1%	280	4%
Materials Research Division	330	339	3%	339	0%	350	3%
Mathematical Sciences Division	244	248	2%	252	1%	263	4%
Physics Division	304	310	2%	313	1%	324	4%
Office of Multidisciplinary Activities	166	170	2%	220	30%	315	43%

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FYI Science Policy | aip.org/fyi

https://ww2.aip.org/fyi/2023/nsf-details-plans-spend-1-billion-budget-increase

Congressional Leaders

PROFILE

Hal Rogers

Chair

House Commerce-Justice-Science Appr…

PROFILE

Matt Cartwright

Ranking Member

House Commerce-Justice-Science Appr…

PROFILE

Jeanne Shaheen

Chair

Senate Commerce-Justice-Science Appr…

PROFILE

Jerry Moran

Ranking Member

Senate Commerce-Justice-Science Appr…

PROFILE

Frank Lucas

Chair

House Science, Space, and Technology …

PROFILE

Zoe Lofgren

Ranking Member

House Science, Space, and Technology …

PROFILE

Maria Cantwell

Chair

Senate Commerce, Science, and Transp…

PROFILE

Ted Cruz

Ranking Member

Senate Commerce, Science, and Transp…

https://ww2.aip.org/national-science-foundation

https://ww2.aip.org/nasa

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PROFILE

Chuck Fleischmann

Chair

House Energy-Water Development Appr…

PROFILE

Marcy Kaptur

Ranking Member

House Energy-Water Development Appr…

PROFILE

Patty Murray

Chair

Senate Energy-Water Development Appr…

PROFILE

John Kennedy

Ranking Member

Senate Energy-Water Development Appr…

PROFILE

Frank Lucas

Chair

House Science, Space, and Technology …

PROFILE

Zoe Lofgren

Ranking Member

House Science, Space, and Technology …

PROFILE

Joe Manchin

Chair

Senate Energy and Natural Resources C…

PROFILE

John Barrasso

Ranking Member

Senate Energy and Natural Resources C…

https://ww2.aip.org/department-of-energy

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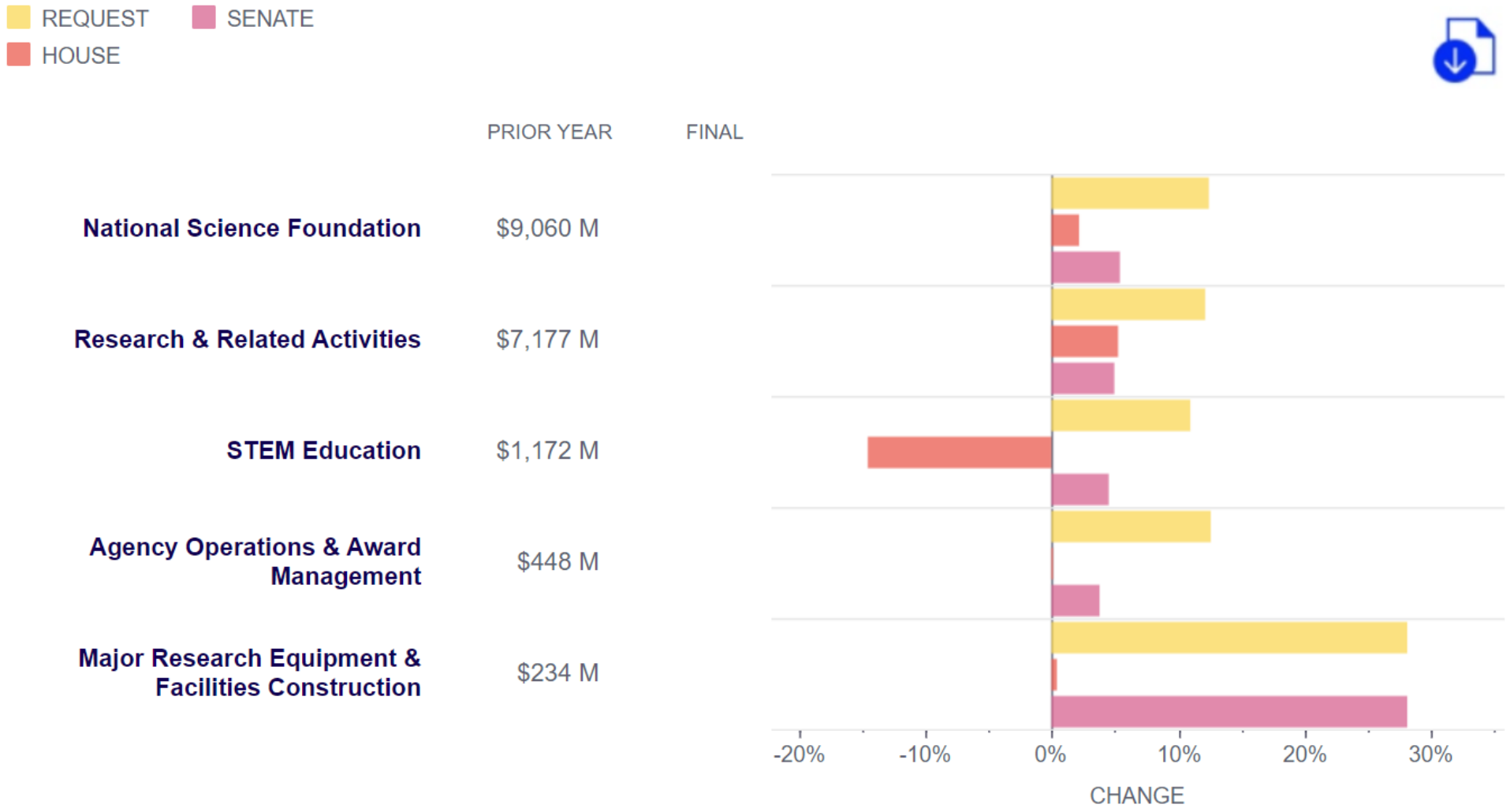
FY2025 Appropriations: National Science Foundation

FISCAL YEAR

2025



https://ww2.aip.org/fyi/fy2025-national-science-foundation

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FY2025 Appropriations: NASA

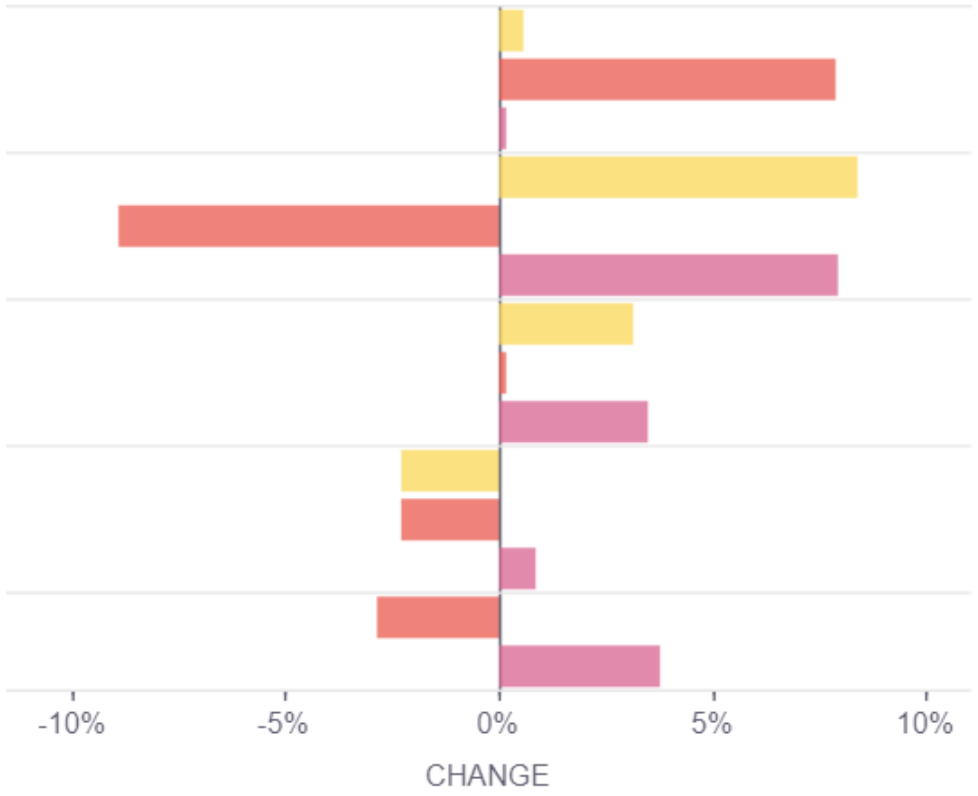
FISCAL YEAR

2025

REQUEST SENATE HOUSE

View NASA overview chart

	PRIOR YEAR	FINAL
Planetary Science	$2,717 M	
Earth Science	$2,195 M	
Astrophysics	$1,530 M	
Heliophysics	$805 M	
Biological and Physical Sciences	$88 M	



https://ww2.aip.org/fyi/fy2025-national-aeronautics-and-space-administration

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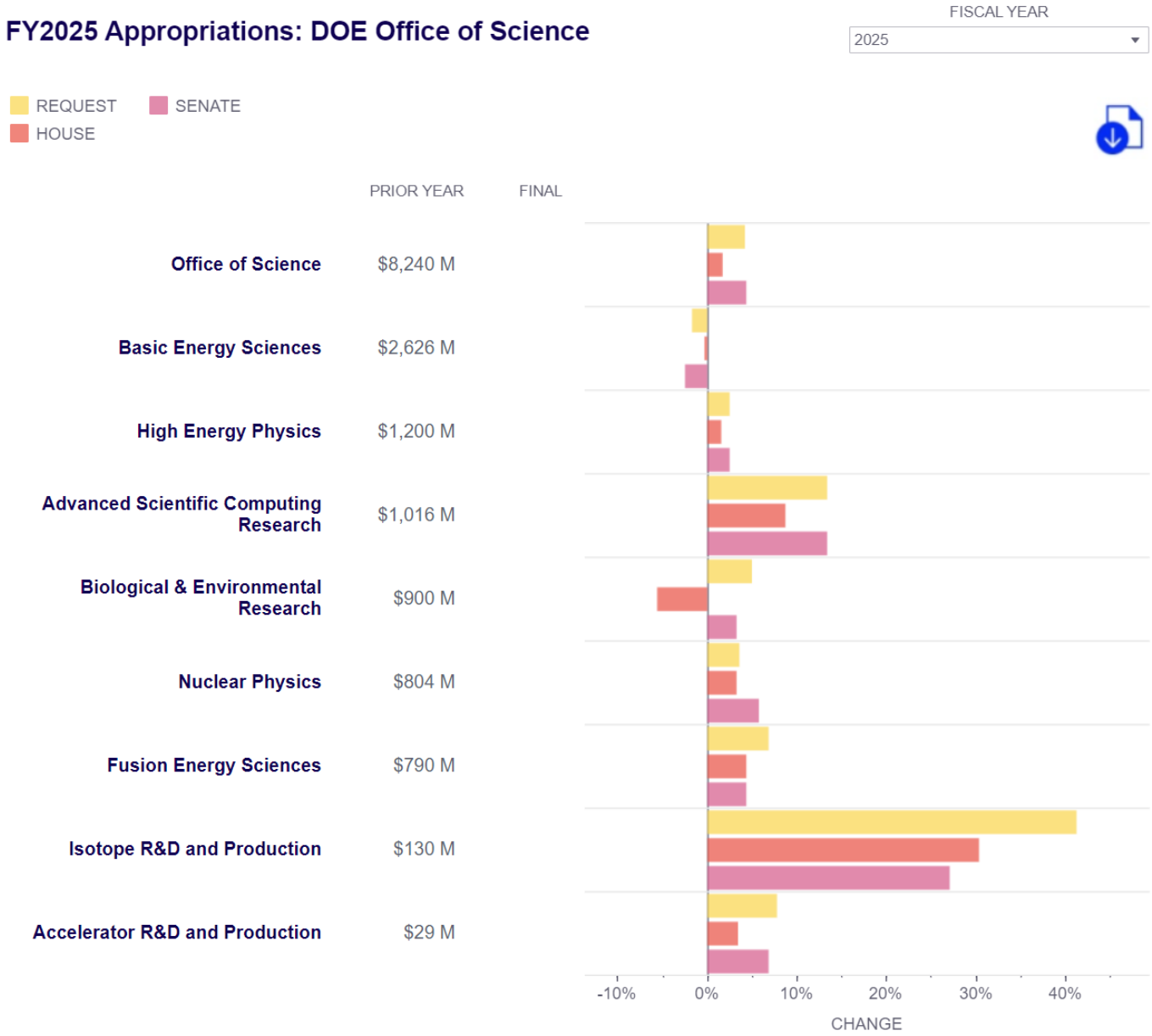
FY2025 Appropriations: DOE Office of Science



https://ww2.aip.org/fyi/fy2025-doe-office-of-science

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NSF's MREFC budget projection in FY24 request

MREFC Account Funding, by Project

(Dollars in Millions)

	FY 2022 Actual[1]	FY 2023 Estimate	FY 2024 Request	FY 2025 Estimate	FY 2026 Estimate	FY 2027 Estimate	FY 2028 Estimate	FY 2029 Estimate
Antarctic Infrastructure Recapitalization (AIR)	$55.20	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00
HL-Large Hadron Collider Upgrade	10.58	33.00	38.00	-	-	-	-	-
Leadership-Class Computing Facility (LCCF)	-	-	93.00	247.00	147.00	33.00	-	-
Mid-scale Research Infrastructure, Track 2[2]	36.67	76.25	105.06	85.00	90.00	100.00	100.00	100.00
Regional Class Research Vessel (RCRV)[3]	-	1.98	-	-	-	-	-	-
Vera C. Rubin Observatory (Rubin)	17.49	15.00	7.61	-	-	-	-	-
Dedicated Construction Oversight	0.65	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total	**$120.60**	**$187.23**	**$304.67**	**$393.00**	**$298.00**	**$194.00**	**$161.00**	**$161.00**

[1] A total of $330.73 million was carried over from FY 2022 to FY 2023: $98.34 million for Mid-scale; $150.65 million for AIR; $6.50 millon for RCRV; $20,467 for the Daniel K. Inouye Solar Telescope (DKIST); $29.68 million for HL-LHC, and $40.0 million for Rubin, $1.18 million for Dedicated Construction Oversight. THe remaining $4.36 million consists of funds from recoveries from old projects not funded in FY 2022.

[2] Outyear amounts are for planning purposes only. NSF will evaluate Mid-scale RI in the context of agency priorities for future budget submissions.

[3] FY 2022 Actual excludes $25.0 million in one-time funding for necessary expenses related to RCRV construction impacted by Hurricane Ida as provided in P.L. 117-43, the "Extending Government Funding and Delivering Emergency Assistance Act."

https://nsf-gov-resources.nsf.gov/2023-08/NSF%20FY24%20CJ_Entire%20Rollup_web_%28ERRATA%20v4%29.pdf

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NSF's MREFC budget projection in FY25 request

MREFC Account Funding, by Project

(Dollars in Millions)

	FY 2023 Base Plan	FY 2024 Request	FY 2025 Request	FY 2026 Estimate	FY 2027 Estimate	FY 2028 Estimate	FY 2029 Estimate	FY 2030 Estimate
Antarctic Infrastructure Recapitalization (AIR)	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00	$60.00
HL-Large Hadron Collider Upgrade	33.00	38.00	-	-	-	-	-	-
Leadership-Class Computing Facility (LCCF)	-	93.00	154.00	226.00	47.00	-	-	-
Mid-scale Research Infrastructure, Track 2[2]	76.25	105.06	85.00	90.00	100.00	100.00	100.00	100.00
Regional Class Research Vessel (RCRV)	1.98	-	-	-	-	-	-	-
Vera C. Rubin Observatory (Rubin)	15.00	7.61	-	-	-	-	-	-
Future Priority Projects[3]	-	-	-	8.00	206.00	264.00	289.00	339.00
Dedicated Construction Oversight	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Total	**$187.23**	**$304.67**	**$300.00**	**$385.00**	**$414.00**	**$425.00**	**$450.00**	**$500.00**

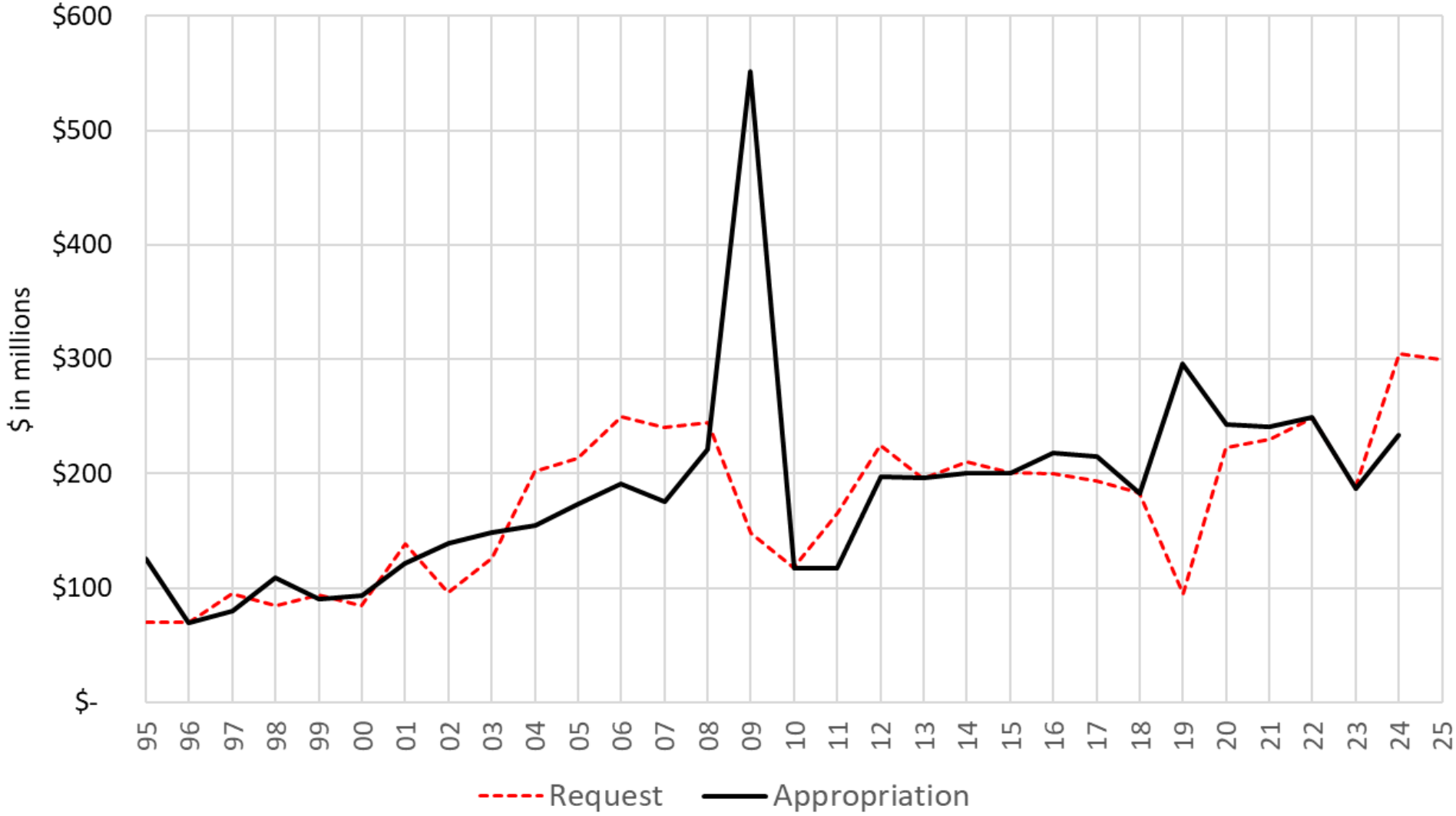
[1] A total of $361.32 million was carried forward from FY 2023 to FY 2024: $74.04 million for Mid-scale RI, $209.76 million for AIR, $8.53 million for RCRV, $39.07 million for HL-LHC Upgrade, $20.89 million for Rubin, and $1.58 million for Dedicated Construction Oversight. The remaining $7.45 million consists of funds from recoveries from old projects not funded in FY 2023.

[2] Outyear amounts are for planning purposes only. NSF will evaluate Mid-scale RI in the context of agency priorities for future budget submissions.

[3] Represents escalating funding amounts increasing NSF's MREFC portfolio to a total of $500.0 million by the end of the decade and does not reflect policy decisions on project-specific investments. Increases reflect both anticipated growth in cost of major research infrastructure, as well as NSF's intent to increase investments in facilities to maintain U.S. leadership in key science and engineering research areas.

https://nsf-gov-resources.nsf.gov/files/00_NSF_FY25_CJ_Entire%20Rollup_web.pdf

NSF MREFC Appropriations History, 1995-2024



https://dellweb.bfa.nsf.gov/NSFRqstApproHist/NSFRequestsandAppropriationsHistory.pdf

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Pending Appropriations Direction for NSF/NASA

118TH CONGRESS, 2d Session } HOUSE OF REPRESENTATIVES { REPORT 118–582

COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS BILL, 2025

JULY 11, 2024.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Mr. ROGERS of Kentucky, from the Committee on Appropriations, submitted the following

REPORT

together with

MINORITY VIEWS

[To accompany H.R. 9026]

https://www.congress.gov/118/crpt/hrpt582/CRPT-118hrpt582.pdf

Calendar No. 444

118TH CONGRESS, 2d Session } SENATE { REPORT 118–198

DEPARTMENTS OF COMMERCE AND JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS BILL, 2025

JULY 25, 2024.—Ordered to be printed

Mrs. SHAHEEN, from the Committee on Appropriations, submitted the following

REPORT

[To accompany S. 4795]

The Committee on Appropriations reports an original bill (S. 4795) making appropriations for the Departments of Commerce and Justice, Science, and Related Agencies for the fiscal year ending September 30, 2025, and for other purposes, reports favorably thereon without amendment and recommends that the bill do pass.

Total obligational authority, fiscal year 2025

Total of bill as reported to the Senate	$76,207,000,000
Amount of 2024 appropriations	69,866,398,000
Amount of 2025 budget estimate	77,183,938,000
Bill as recommended to Senate compared to—	
2024 appropriations	+6,340,602,000
2025 budget estimate	−976,938,000

https://www.congress.gov/118/crpt/srpt198/CRPT-118srpt198.pdf

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ELT language: both support two-observatory approach

Astronomy and Astrophysics Decadal Survey Priority Facilities.—The Committee understands that the Decadal Survey on Astronomy and Astrophysics 2020 (Astro2020) has developed a comprehensive research strategy and vision for the future of astronomy and astrophysics, particularly as it relates to ground-based instruments and observatories, including the U.S. Extremely Large Telescope Program (USELT) and the Next Generation Very Large Array. The recommendation includes $30,000,000 for design-related funding. The Committee acknowledges NSF has announced a process by which it will decide how best to advance the USELT and strongly encourages NSF to ensure that the USELT includes a two-observatory footprint with a mechanism to guarantee robust community access. The Committee notes that advancing these projects will ensure that the U.S. can maintain world leadership in astronomy for the benefit of U.S. innovation, STEM careers, and national security. The Committee directs NSF to provide regular briefings on the status of the USELT and encourages NSF to minimize delays and reduce risks to cost growth on the highest ranked large-scale, ground-based projects that have submitted plans to the agency review process and which are already beyond the planning and preliminary design phases.

Astronomy Current Facilities.—The Committee directs NSF to ensure there is adequate support for operational costs and maintenance at its current astronomy facilities, as it considers new astronomy investments.

House report

Astronomy.—The Committee expects NSF to provide appropriate levels of support for operating its current facilities, developing instrumentation, and preparing for investments in future world-class scientific research facilities. The National Academies of Sciences, Engineering, and Medicine [NAS] Decadal Survey on Astronomy and Astrophysics 2020 [Astro2020] outlines a comprehensive research strategy and vision to maintain U.S. science and technology leadership at the frontiers of astronomy and astrophysics for ground-based instruments and observatories. The Committee therefore provides $100,000,000 for NSF to support the development of next generation astronomy facilities recommended in Astro2020.

The Committee remains strongly supportive of a two-hemisphere, U.S. Extremely Large Telescope [USELT] program with a robust user support system and data archive to ensure broad U.S. community access. This is consistent with the direction in division C of the joint explanatory statement accompanying Public Law 118–42 and Astro2020. NSF, within the construct of the National Science Board approval process, is encouraged to advance the design of these Astro2020 priority projects during fiscal year 2025 so that appropriate Major Research Equipment and Facilities Construction funds can be included in the fiscal year 2026 budget request. The U.S. ground-based astronomy program has been the leader in this critical basic science for more than a century, and the NSF has helped ensure open access to scientists regardless of their academic institution affiliation. The USELT program will provide unprecedented opportunities for scientific discovery and represents the only major science program undertaken by the Federal Government with a 50 percent cost share by non-Federal partners, including major U.S. allies. Not later than 90 days after enactment of this act, NSF shall brief the Committee about how the Foundation intends to implement this congressional direction.

Senate report

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Senate concern about Antarctic infrastructure

Antarctic Research Infrastructure.—The Committee is concerned about recent announcements to pause Antarctic field research and delay project design for the fourth-generation ground-based cosmic microwave background [CMB–S4] and IceCube-Gen2 due to Antarctic infrastructure challenges. The Committee understands the difficult environment NSF is facing and has provided substantial support for Antarctic Infrastructure Modernization for Science and Antarctic Infrastructure Recapitalization over several years to upgrade infrastructure at McMurdo, Amundsen-Scott South Pole, and Palmer Stations. This effort is now many years behind schedule stretching potentially another decade before completion. Delays to CMB–S4 and IceCube-Gen2 threaten loss of U.S. leadership as competitors set up new Antarctic research efforts, loss of partner support for new science facilities, and major setbacks in our understanding of sea ice and other Antarctic changes that are critical to coastal resilience.

Senate concern about Antarctic infrastructure (cont.)

The Committee is additionally concerned that decisions to pause major facility design have been made without proper consultation of the community and of relevant stakeholders within the Foundation. The Committee expects NSF to request adequate resources to enable concurrent infrastructure upgrades with ongoing research and major facility planning. NSF shall provide the Committee a comprehensive plan not later than 180 days after enactment of this act that provides, at a minimum, timelines, milestones, and funding requirements for future Antarctic upgrades that enable continued Antarctic field research, new Antarctic Research Vessel deployment, and a reasonable design path for high priority South Pole physics experiments.

Support for IceCube-Gen-2

Neutrino Observatory.—The Committee is aware of the many important scientific contributions being made by the South Pole neutrino observatory IceCube, the current upgrade underway, and the initial planning for the next generation facility IceCube-Gen2 as recommended in Astro2020 and the Particle Physics Project Prioritization Panel (P5). The Committee encourages NSF to consider development activities for IceCube-Gen2 and to ensure an appropriate transition between the IceCube upgrade and IceCube-Gen2 construction projects to leverage lessons learned and knowledge transfer from one project to another.

House report

Neutrino Research.—The Committee is aware of the many important scientific contributions being made by the South Pole neutrino observatory IceCube, the current upgrade underway, and the initial planning for the next generation facility IceCube-Gen2 as recommended in Astro2020 and the Particle Physics Project Prioritization Panel. NSF should consider development activities for IceCube-Gen2 and ensure an appropriate transition between the IceCube upgrade and IceCube-Gen2 projects to leverage lessons learned and knowledge transfer from one project to another.

Senate report

Senate support for Facility Operations Transition program

As major research facilities transition from construction, funded in the Major Research Equipment and Facilities Construction account, to science operations and maintenance, funded in R&RA, it is necessary for NSF to accommodate this shift without impacting the existing scientific activities. The Committee notes that as a result of the National Science Board's "Study of Operations and Maintenance Costs for NSF Facilities" the agency created the Facility Operation Transition pilot to enable this shift. The Committee expects that as major research facilities, such as the Vera C. Rubin Observatory, move from construction into science operations NSF will continue to use the Facility Operation Transition to allow the ongoing operations and maintenance costs to gradually be absorbed into the managing division or directorate. Further, as part of the fiscal year 2026 budget request, NSF shall provide a 5-year operations and maintenance budget outlook for facilities that have recently graduated from the Major Research Equipment and Facilities Construction account.

Support for Chandra

Chandra X–Ray Observatory.—The Committee supports continued funding for the Chandra X–Ray Observatory, which continues to deliver discoveries addressing a wide range of questions across astrophysics.

House report

Astrophysics.—The Committee recommendation for Astrophysics includes not less than $98,300,000 for the Hubble Space Telescope; up to $72,100,000 for the Chandra X-ray Observatory; $187,000,000 for the James Webb Space Telescope [JWST], including for current outreach activities; $384,000,000 for the Nancy Grace Roman Wide-Field InfraRed Survey Telescope; and up to $269,400,000 for Astrophysics Explorers. The Committee recognizes that both Hubble and Chandra continue to make transformative discoveries and provide key capabilities that augment and complement the JWST and help secure U.S. leadership in space and science but will eventually need to be decommissioned as their capabilities degrade and resources are prioritized to other observatories.

Senate report

Direction for DOE HEP

The Committee supports research in extreme ultraviolet lithography technology and its ability to advance semiconductor manufacturing. The Department is directed to continue to support advanced accelerator technologies and support translational research to move technology out of the national laboratories.

The Committee supports the Department's role in the Alpha Magnetic Spectrometer experiment and encourages the Department to conduct research projects that focus on studying the temporal and spatial evolution of cosmic ray and magnetospheric particle data within the giga electron volt energy range.

The recommendation provides not less than $37,500,000 for the Sanford Underground Research Facility and $10,000,000 for the Accelerator Controls Operations Research Network.

The Committee supports the Cosmic Microwave Background Stage 4 (CMB–S4) experiment and the recommendations of the Particle Physics Project Prioritization Panel. However, the Committee notes the plan for CMB–S4 has recently undergone major changes. Therefore, the Committee provides no further increase in funding while planning efforts are underway to determine a final path forward for CMB–S4. The Committee will continuously re-evaluate this position as new planning and cost estimates become clear.

https://www.congress.gov/118/crpt/hrpt580/CRPT-118hrpt580.pdf

HIGH ENERGY PHYSICS

Research.—The Committee recommends not less than $36,000,000 for the Sanford Underground Research Facility; and not less than $33,700,000 for the HL–LHC Upgrade projects.

The Committee encourages the Department to fund facility operations at levels for optimal operations. The Committee encourages the Department to fund facility operations and MIEs at optimal levels.

https://www.congress.gov/118/crpt/srpt205/CRPT-118srpt205.pdf

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Questions?

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